RGS Focal Plane Camera (RFC) Technology and Implementation

George Ricker
MIT

Constellation X
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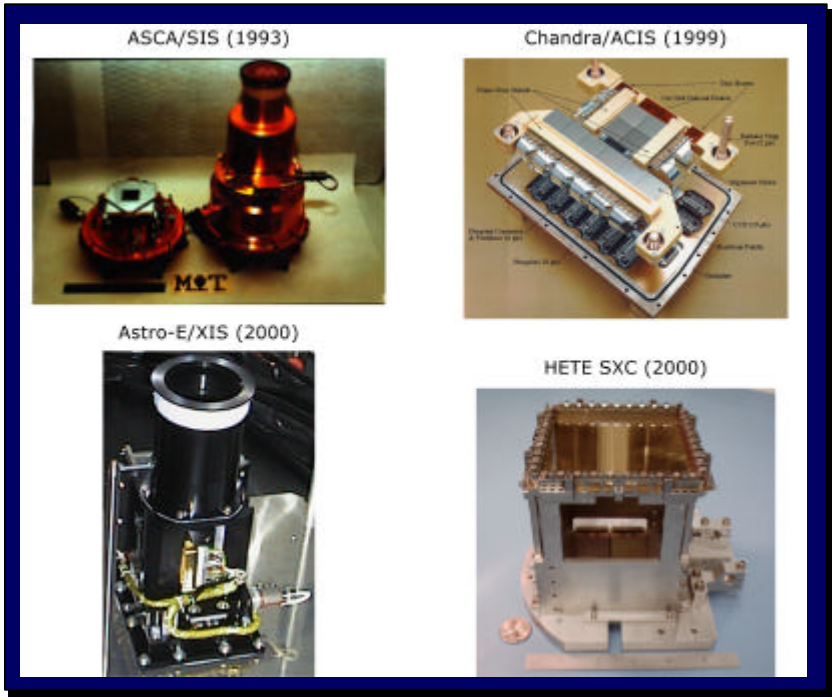
RFC Heritage and Drivers

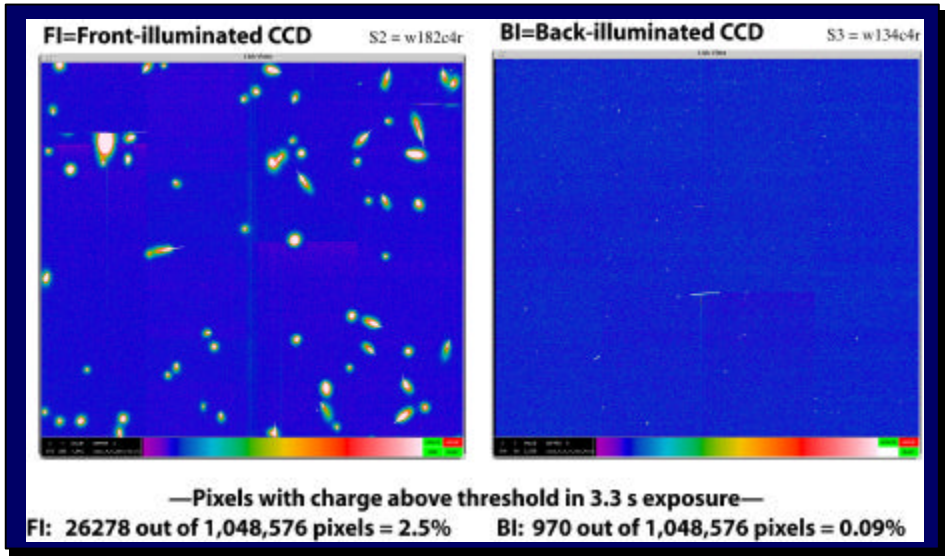
Flight Heritage



Key Technology Drivers for RFC

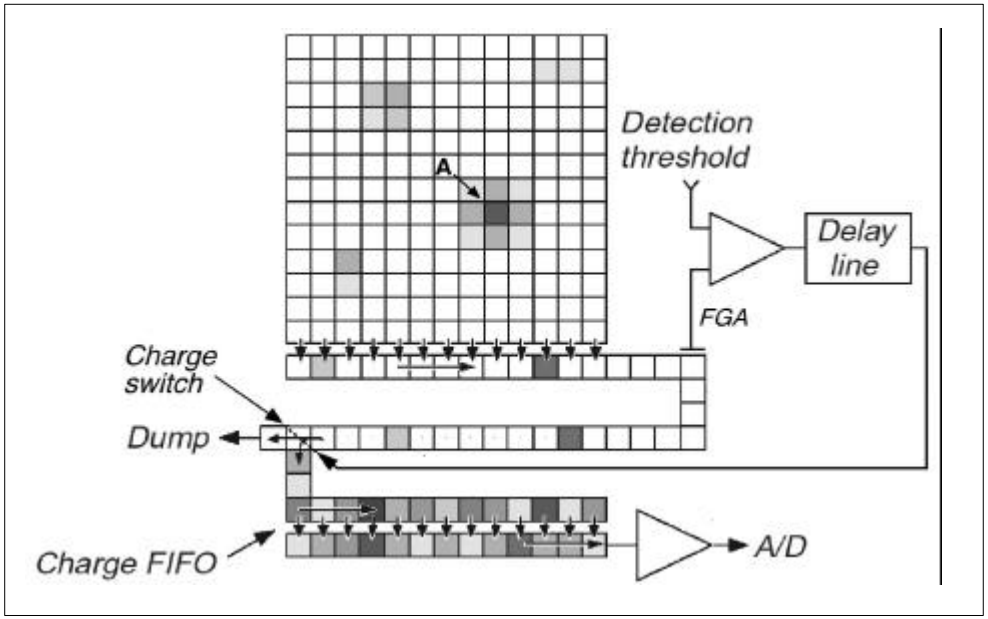
- High QE for 0.25 - 2 keV band
- High yield for back illuminated CCDs
- Adequate energy resolution at low E_x
  - Grating order separation
  - Particle background rejection
- Radiation tolerant at L2

Chandra Single Frame Background Images



Pixels with signal charge are sparse in X-ray astronomy images...only ~10^{-2} to 10^{-3} of pixels contain signal charge

EDCCD: Description and Advantages



- **Event-Driven CCD: Advantages**
  - Pixels are non-destructively sensed, and only those with signal charge are saved and digitized
  - Compatible with high yield BI processes
  - High speed: 100 x Chandra/ACIS (greatly reduced pileup)

- **Additional Advantages of EDCCD**
  - Improved QE for 0.2 - 2 keV band
  - High frame rate (30-50 Hz); thus, can use thinner optical blocking filter (OBF)
  - High yields and reduced risk
    - Conventional MOS CCD processing
    - Compilation of separately-tested innovations
    - Flight-proven (ASCA, Chandra) key elements
      - Parallel register array
      - Low noise floating diffusion output amplifier

- **System Constraints relief for Con-X**
  - Lower power dissipation at a given frame rate (>100 x less)
  - Enables integrated flight camera testing at room temperature
  - Compatible with broad operating temperature range (~ 0° C to -120 ° C)
  - Reduced shielding requirement (>10x more radhard)
  - High frame rate: relaxed S/C stability and jitter requirements

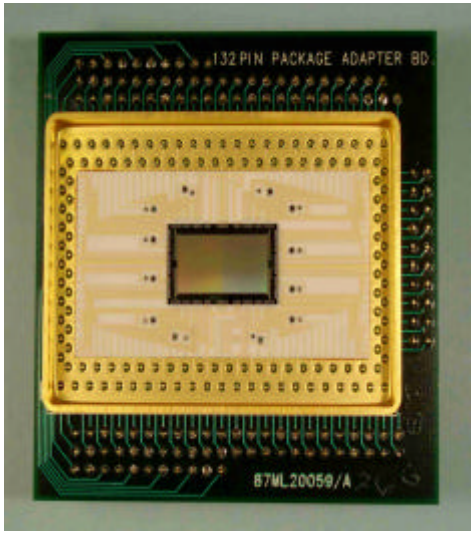
Re-Baselining of RGS CCD Technology

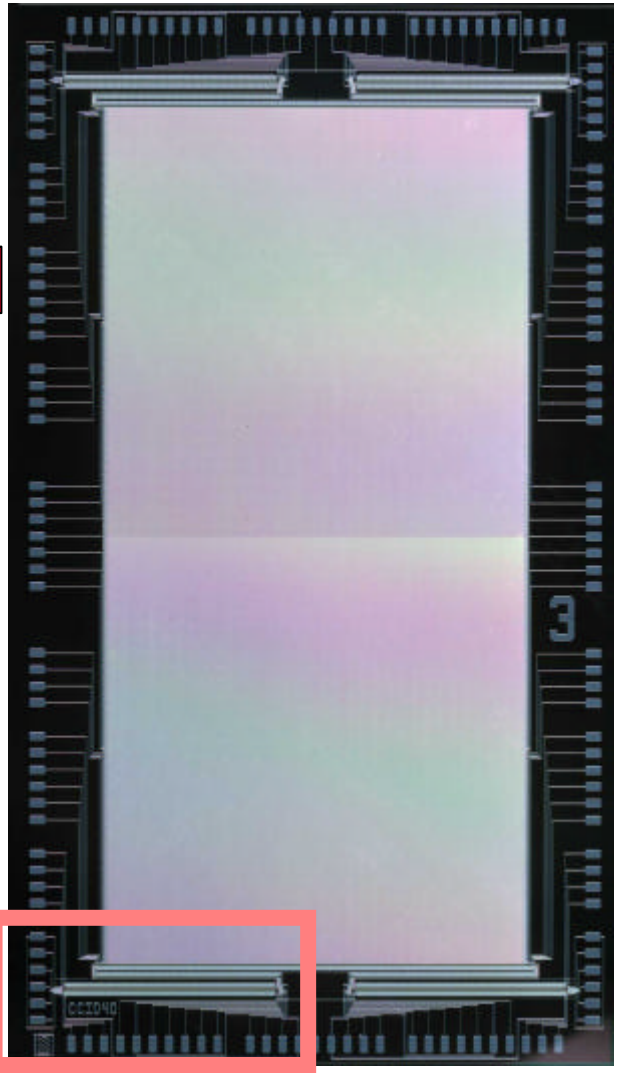
- Peer Committee of independent CCD specialists convened by Con X Project to assess whether RGS readout should be re-baselined from resistive gate CCD (RGCCD) to event-driven CCD (EDCCD).
- Members: A. Ewin, J. Geary, K. Gendreau, C. Kotecki
- Committee met at GSFC on 2002 September 5 for presentations and deliberations.
- *Recommendation was unanimous that EDCCD approach be adopted.*

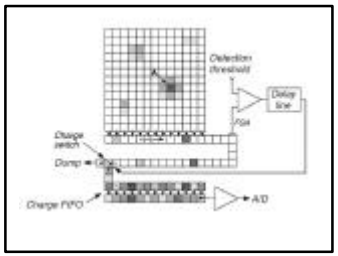
EDCCD Technology Status

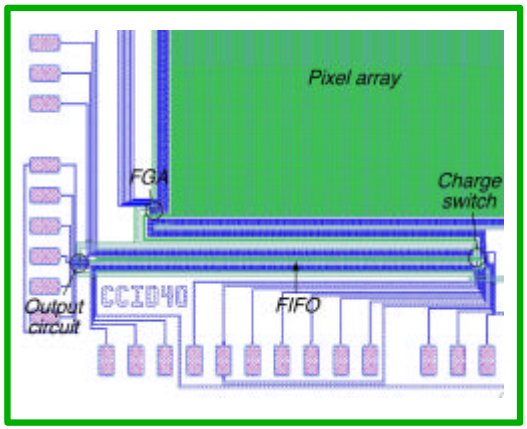
Gen 1-Lot 1 EDCCD

- *512 x 512*
- *Proof-of-concept*
- *Unthinned Device*
- *Delivered 2/20/03*



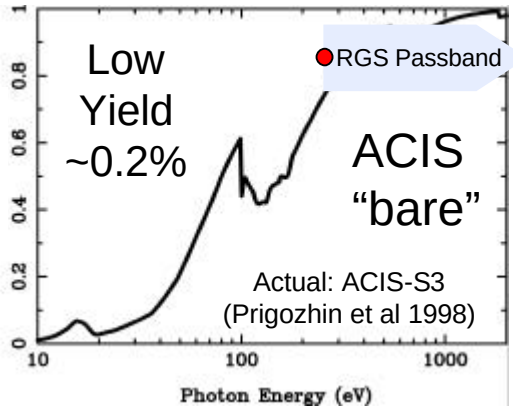


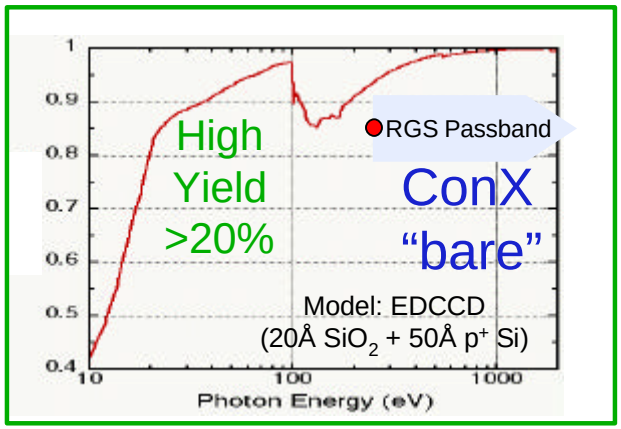




Quantum Efficiency Comparison: ACIS-S3 (BI) vs EDCCD (BI)

- Plots at left show QE of "bare CCD" ie no optical blocking filter (OBF)





• = QE_{spec} at 0.25 keV

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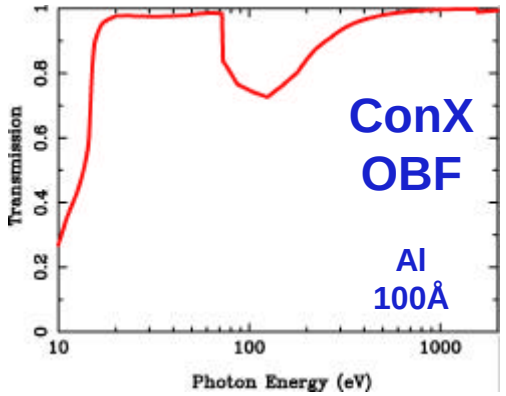

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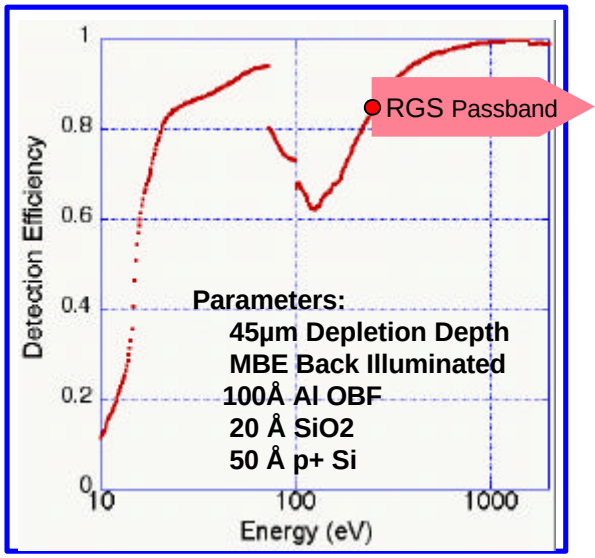
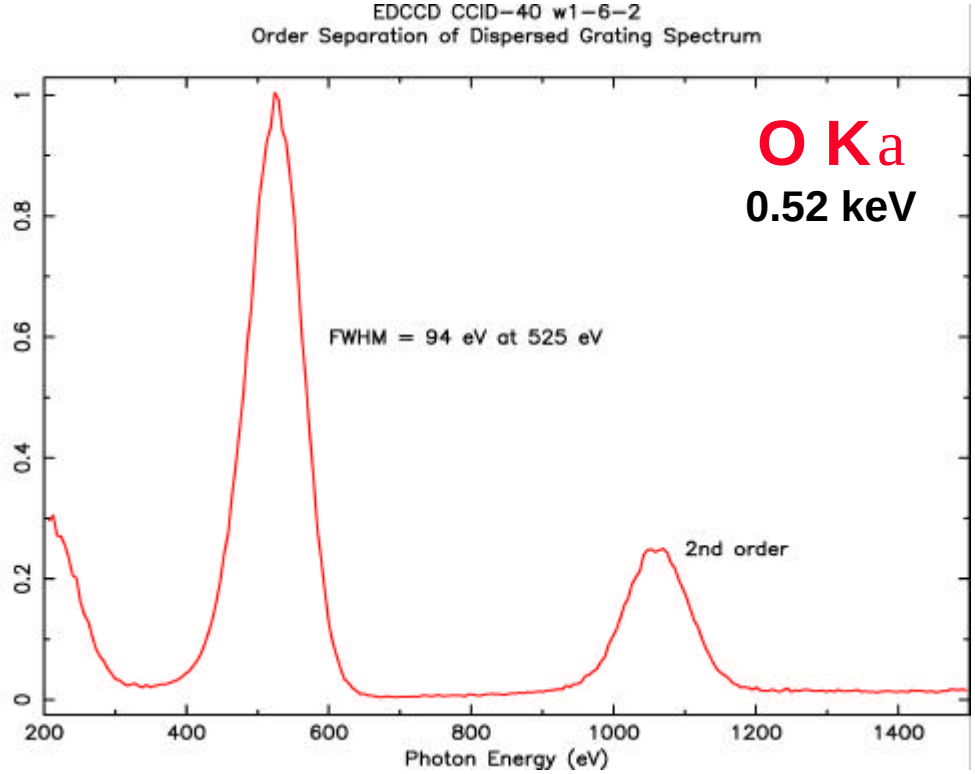
EDCCD + OBF:Predicted QE

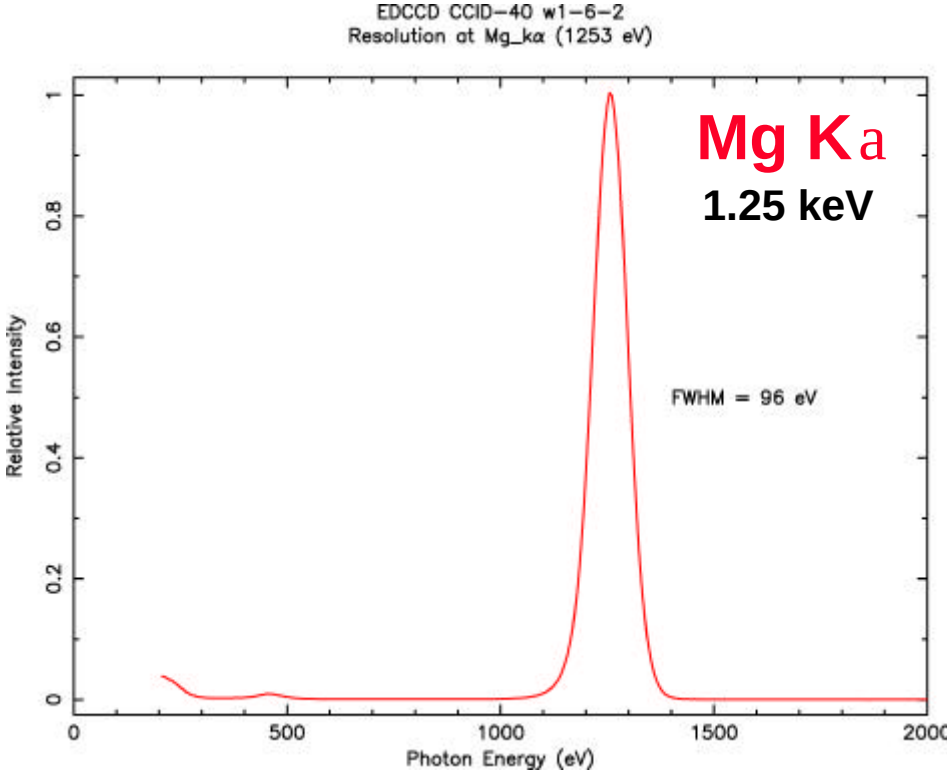


Conclusions:

- An EDCCD uses >10x thinner OBF than ACIS >>> higher X-ray transmission at low E_x
- MBE-BI EDCCD should meet ConX low energy QE specification

Measured X-ray energy resolution of the Gen1-Lot 1 EDCCDs





- **Note: Operation of the CCID-42 as an extended serial register, conventional CCD provides energy resolution comparable to that of the best traditional X-ray CCDs. Preparations for fully event-driven operation are in progress.**

Near Term Development Focus for RGS Focal Plane Camera

- **EDCCDs:**
  - Complete Testing of Gen 1-Lot 1 (in process)
  - Initial Radiation Tests
  - Mask Design & Lot Fab for Gen2-Lot1 (June-Oct 04)

- **Measure QE at E_x = 0.25 keV and below**
  - MBE process devices
  - Low temperature metal BI devices

- **Assess camera impacts for:**
  - $E_{x,\,low}$ < 0.25 keV (ie $E_{x,\,low}$= 0.125 keV would double array length)
  - Off plane design (ie crescent-shaped focal plane)